ASSESSING POROSITY STRUCTURE IN EUROPA'S CRUST. J. Eluszkiewicz, Atmospheric and Environmental Research, Inc., 131 Hartwell Ave., Lexington, MA 02421, jel@aer.com.

Introduction: Knowledge of the density structure (i.e., porosity) in Europa's outer shell is very important in evaluating the prospects of a sounding radar in detecting a subsurface ocean [1] and in studies of the origin of geological structures [2]. Density structure is also likely to affect the rate at which minor constituents, including those that affect the radar signal, as well as possible biological markers, diffuse from the interior to the surface. The primary process affecting the density structure (and the closely-coupled thermal structure) of Europa's subsurface layers is self-gravitational compaction. The depth of a porous regolith on an Europa-size icy satellite has previously been estimated to exceed 1 km [1, 3]. In view of the critical importance of the density structure in the design and interpretation of upcoming JIMO/Europa mission (especially a radar instrument), the time has come to re-examine that estimate, including an assessment of the associated error budget.

Ice Metamorphism on Europa: In addition to affecting the density structure in the dry regolith, compaction will influence the depth of the transition zone between ice and liquid characterized by a network of brine pockets. In this transition zone, compaction is likely to proceed as a two-phase flow, with liquid being squeezed out from the collapsing pore space. Once the pore space loses interconnectivity, the elimination of the remaining brine pockets will be limited by the solubility of the brine constituents in the surrounding ice matrix. As the radar attenuation is expected to increase rapidly in this transition zone [4], an estimate of the depth of this zone will provide an upper limit to the depth of penetration of the radar signal (the actual penetration depth is likely to be smaller and determined by volumetric scattering in the dry regolith [1]). Another metamorphic process operating at depth on Europa is grain growth in the ice matrix. Grain growth will affect the concentration gradients of minor constituents, as the latter tend to diffuse more rapidly along grain boundaries than through the crystal interior [5].

Approach: Uncertainties in ice rheology under Europan conditions are the largest source of error in evaluating the density structure, although the p-T conditions in Europa's regolith are closer to those in terrestrial ice than conditions in the smaller and/or more-distant-from-the-Sun icy satellites. Consequently, an investigation of compaction on Europa can to some extent make use of rheological data for terrestrial ice, especially as the ice/liquid boundary is approached. In its most general form, calculating the density structure of Europa's subsurface layers presents a coupled microphysical/thermal/chemical problem that is best addressed via an integrated approach based on the multi-phase flow formalism [6]. In such an approach the heat and mass transfer equations are solved self-consistently, using material data for ice extrapolated to Europa from terrestrial conditions. A first-order estimate of the regolith depth can be obtained by applying equations describing compaction driven by dislocation creep, applied both to a dry regolith [1, 7] and to a regolith filled with liquid [6]. This initial estimate of density and thermal gradients should be followed by an evaluation of salt concentration gradients (taking into account grain growth and its impact on the salt diffusion coefficient) and their impact on the radar return. The density and thermal structure of Europa's regolith should be computed on a variety timescales corresponding to the geological processes that are likely to generate significant porosity.

References: [1] Eluszkiewicz J. Presentation at 35th DPS Meeting [2] Nimmo et al. (2003) *Icarus, 166,* 21. [3] Eluszkiewicz J. and Stevenson D. J. (1990) *LPSC XX,* 264. [4] Moore J. C. (2000) *Icarus, 147,* 292. [5] Wolff E. W. et al. (1989) *Geophys. Res. Lett., 16,* 487. [6] McKenzie G. H. (1984) *J. Petrol. 25,* 713. [7] Eluszkiewicz, J. (1990) *Icarus, 84,* 215.